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SOME CONCLUSIONS BASED ON STUDIES IN CEREBRAL ANTHROPOLOGY[1]

By C. W. M. POYNTER

DURING the past five years the Department of Anatomy, University of Nebraska, has been particularly interested in cerebral morphology. We have had opportunity to study about one hundred and fifty brains collected from the material which has come through the usual channels to the department. From this material we have been able to collect a number of brains of Negroes with marked negroid characteristics. These have formed the basis of our racial comparison with the Caucasians until recently, when we secured several brains of Mexicans and one Indian. Doctor Keegan, who is interested with me in this work, has reported his study of the Indian brain and has just completed, through the kindness of Dr. Hrdlička, the study of three other Indian brains.

A review of the literature of cerebral anthropology would give one the impression that the field is an unprofitable one. Relatively little work of a truly anthropological character has been done, and in the light of our limited knowledge of morphology it is premature to conclude that the brain presents no ethnic characteristics. At first one is inclined to ask why so much energy has been expended on craniology and the brain been so neglected. This is explained, however, when we consider that racial studies are of a very special type and must be based on a thorough understanding of morphology. Our knowledge of the skull is relatively ancient; Galen gave a very satisfactory description and the work of Vesalius left little for later observers to add, while in the case of the brain, the first fact of cerebral localization was pointed out by Broca less than fifty years ago. Because of the lack of understanding of the anatomical structure, brain studies have been largely empirical records of observable variations and elaborations of extravagant theories based on uncertain evidence. It is not surprising that so thorough a student as Doctor Mall should conclude that,

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[1] Read before the American Anthropological Association, New York, 1916.

> With our present crude methods, the statement that the negro brain approaches the foetal or simian brain more closely than does the white is entirely unwarranted.

The question of brain weight which received so much attention at one time, we know now may be dismissed with the statement that the weight of the brain, independent of other data, is without significance.

Cerebral study is very difficult because of the number and complexity of the functions which are expressed in its structure. The evidence at hand seems to suggest that somatic, psychic, and racial characters are expressed in the pattern of the sulci and gyri and the problem in both morphology and anthropology is to discover a method of recognizing and separating these influences. These difficulties are, however, no more insurmountable than some of those which have already been solved in neurological work and should, it seems to me, command our interest and attention.

Variations in fissures and convolutions are so numerous in kind and degree that it has proven impossible statistically to establish a type of variation for race, sex, or degree of mental attainment. Perhaps it would be better to say that we do not know the significance of variations which fall outside of the fissural pattern which we recognize as common to all brains. Does a certain type of mental development tend to produce a certain fissural pattern, or is a child with a certain fissural pattern capable of receiving training more easily along some special line than another without this pattern? If a race is found to possess certain particular fissural characters are they due to psychic or environmental influences, or are they definite morphological characters which have evolved with the evolution of the race? These and like questions cannot as yet be answered positively, but I feel that we are nearer the answer than we were a few years ago.

In an organ so extremely specialized as the brain there is undoubtedly morphological expression for both the physical and psychical functions, but to appreciate these we must use methods of examination very much less crude than those formerly employed in brain examination. Also the method which has been most frequently used in the study of races, that is the selection of a number of arbitrary characters, and the tabulation of their percentage of variation, will not yield profitable results because these characters have no significance. We must not expect to find in the brain racial characters as obvious as prognathism or pigmentation.

Another problem which adds to the difficulties in this field is that of development. The suggestion has frequently been made that the brains of the so-called lower races present a greater variety of variations which suggest the embryonal or simian condition. This would be of special value in racial studies if it could be proven true, but unfortunately we know very little of the developmental processes of the brain cortex and those characters which we are accustomed to speak of as embryonal are determined from a superficial study.

It seems to me that, notwithstanding the difficulties which I have just reviewed, the field of cerebral anthropology offers an interesting and profitable field for research. Most of the work of the past, with the exception of the records it has furnished which may possibly be valuable for later comparisons, has its greatest value in showing us the futility of research in certain directions. In the recent work of Elliot Smith however we have a suggestion of how the newer facts concerning the brain may be made use of in the interpretation of fissural variations which heretofore have been meaningless.

This work of Smith is valuable because it deals with a known functional area, and while it is based on a small amount of absolute evidence of the primary relation between sulci and cortical functional areas, the results of its application are so convincing that one is bound to accept the principle. Briefly stated, his work consisted in aking the area striata, which is the most definitely circumscribed area of the cortex, and by comparison of this area in man and apes determine the way in which brain development is expressed on the brain surface. In the light of this work the direction of a fissure takes on a real significance.

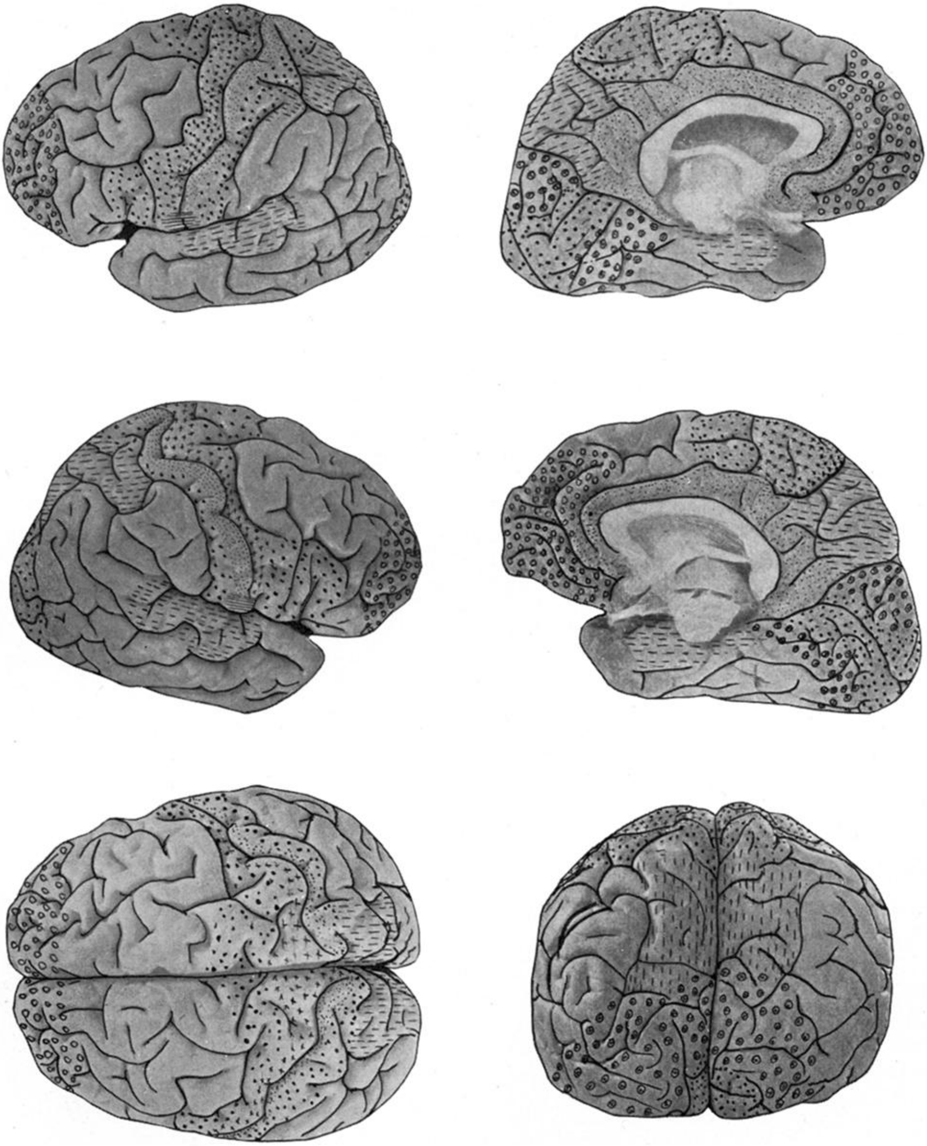
The method is not capable of immediate application to all portions of the brain both because of our lack of knowledge of morphological and functional areas of many portions of the cortex and because other areas are not definitely defined macroscopically as is the area striata. In addition to this the elements affecting development in different portions of the brain are so complex that perhaps they do not always react against each other in the same way, so that in some parts the morphological picture will always remain incomprehensible, but if this be true it will be in the smaller details and still leave much for us to expect from the study.

The experimental work on the cortex which has recently occupied the attention of several laboratories throws light on our problem not only in morphology but on the somatic functional side as well. Doctors Sherrington and Mott, by experimental processes in localization on the ape's brain, have reached the conclusion that,

> Habits and mode of life of the animal determine the convolutional pattern of the brain and the relative superficial area of the archipallium to the neopallium.

This is not a startling conclusion for it is in line with what any trained biologist would expect and agrees with observations on other structures of the body, but is opposed to some of the extraordinary theories which have been advanced relative to the brain.

While, as I have just pointed out, it is impossible to make use of functional areas over a large portion of the brain because they are not known, this need not deter us in these studies till other sciences have cleared up these questions. We have proof in the work of Flechsig, Campbell and Broadmann that the fissures are related to many areas of particular histological character and development. This makes it possible, as Professor G. Elliot Smith has pointed out, to substitute histological areas for functional ones, and to make a topographical survey of the cortex in which fissures become boundaries of definite areas instead of being treated simply as morphological structures. While there is still much to be desired in the method, it at least makes use of all of the knowledge at present available and furnishes a means for comparison between brains of individuals and races. These histological areas will no doubt sooner or later be interpreted by physiologists and prove to be functional areas.



BRAIN OF MEXICAN, MALE, AET., 32

It must be remembered that on a surface diagram it is impossible to give a correct idea of the various fields; in the case for example, of the precentral and postcentral areas the bottom of the *sulcus centralis* and not the lip is the boundary. The areas outlined correspond to those laid down by Campbell in his 1905 monograph.

I think that all who have worked on the brain will agree with Doctor Sherrington that the fissures "are not reliable landmarks" and consequently do not have the morphological significance which was, at one time, attributed to them. On the other hand each one, even of the secondary fissures, stands as a definite expression of interaction between circumscribed cortical areas. Doctor Campbell says of the fissures,

> The fields of the cortex dominating the primary and essential functions are all deposited in relation to important fissures.

As remarked above, it seems to me useless to study fissures alone and attempt to record their minute variations, but we may give them a new significance by relating them to histological areas. I have used the method of macroscopic examination of the cortex suggested by Smith as a substitute for the more laborious histological methods and find it quite satisfactory for fresh material. On hardened material, which makes up the bulk of my specimens, it has proven impractical. I prefer then to use the cortical map which Campbell worked out, not only because the work can be checked by histological examination at any time but because fewer areas are involved, which with our present physiological knowledge seems to me to be a decided advantage.

The accompanying illustrations of a Mexican brain, plate XV, are introduced to show our method of making records. Photographs are made of the brain in the usual way, then the brain is very carefully studied and the fissures are traced on the photograph with India ink, lastly the histological areas are marked out. If it is desirable to make a simple line drawing it is only necessary to bleach the completed photograph by one of the usual methods and a black and white line drawing is the result, for the India ink is not affected by the process. I prefer pictures like those in the accompanying plate, for they have all of the advantages of both the usual line drawings and photographs. The plotting of cortical areas furnishes a great aid to the interpretation of fissures and renders the comparison of the development of different areas possible.

This is not the place for recounting details or making comparisons which are at best involved. Any one who is interested in these may review them in our papers which are published elsewhere. I desire to state a few conclusions based on the studies we have made by the method just outlined.

The Negro brains of our series present a very interesting condition in the frontal region. A number of authors have spoken of the ill-filled or underdeveloped frontal region. If we may apply the same reasoning to this region as has been applied to the occipital region, and I see no reason why the process of growth adjustment may not be the same in both, the frontal association area bounded by the superior and inferior frontal sulci may be considered as the site of a variable growth activity. The expansion of the area will push the superior frontal sulcus upward and diminish the prominence of the *sulcus frontalis mesialis*, and, as in the case of the *sulcus occipitalis inferior* of the occipital region, will cause disintegration of the *sulcus fronto-marginalis*. If the development of the frontal association area is slight the converse would be true, that is, the *sulcus fronto-mesialis* would be present and the *sulcus frontalis medius* poorly developed. We have found the latter condition remarkably constant in our series of Negro brains which would suggest poor development of the frontal region or more specifically of the frontal association area. It might be suggested that this condition is due to dolichocephaly, but, judging by a comparison which we have been able to make with a small number of Caucasian brains, the condition is uninfluenced by head shape.

Cunningham thought because the *sulcus frontalis mesialis* is absent in apes and present in man that its simplicity indicated inferiority. We are forced to conclude that it merely represents a human accessory sulcus whose complexity depends on the width of the *gyrus frontalis superior*. The prominence of the *sulcus frontalis mesialis* would seem to indicate, if not a poorly developed brain, at least a lack of development in the frontal association area.

A number of observers have noted the prominent parietal lobe in the Negro brain. This condition was noted in all of our series and particularly in the region of the *lobulus parietalis inferior*, which presents a mushroom-like outgrowth which overlapped the surrounding cortex by operculi. There appears to be also a variation from the accepted type of fissuration in this region. It is undoubtedly an expression of the prominent growth of the inferior parietal region. It is in the nature of one or more accessory fissures situated behind the termination of the fissure of Sylvius. Smith has probably figured it as a dividing sulcus between the inferior parietal areas which he marks "A" and "B."

When we take into consideration all of the relative characteristics of the Negro brain we may conclude that, while it does not necessarily suggest a closer relation to the apes, it is not as highly developed as that of other races observed and is consequently inferior to them.

In the case of the Mexican and Indian brains we have insufficient data to formulate any conclusions on racial characteristics but from the material at hand it seems that they possess all of the elements necessary for higher individual development. On account of the mixture of races the Mexicans do not make the most desirable material for study, but the case of the Indians is quite different. I feel that every effort should be made to secure and preserve brains of this race before the opportunity is lost to science.

Embryological researches have already contributed much to our knowledge and may still prove to be one of the most valuable methods for clearing up brain problems. Cortical functional areas which are hardly suggested by histological differences may be definitely outlined by a careful study of the differences in the time at which myelinization occurs. Not only may the surface of the brain be subdivided in relation to the time of appearance of the medullated fibers, but these fibers can be traced through the subcortical paths and a suggestion of the function of the area be obtained. I fully appreciate the difficulties Flechsig has had in this field and do not suggest embryological research to the exclusion of other methods of investigation but only as an adjuvant to them.

With an improvement in cytological technique it may be possible to learn more of the cortical nerve cells, the time of their appearance and their development. Such facts would add much to the adult histological studies.

The question of the development of the fissures is not settled.

The theory which assumes that cerebral convolutions have their origin in a disproportion of the brain surface to the skull with a resulting reciprocal mechanical influence on various parts of the brain is too generalized for our purpose. The use of the term "mechano-functional" condition may be comprehensive but does not explain the developmental process. I have applied the Weber method, which Scammon used so successfully in the study of the early pancreas, to this problem. While I am not yet in a position to make a positive statement the evidence at hand seems to suggest that a definite growth process in the region of the fissures is a factor in their formation.

It would seem that cerebral anthropology is dependent for its ultimate development on functional localization in the cerebral cortex. Such localization involves so many different factors that we can not hope for a solution of the problem by any one method of research or by any one department, but only by a thorough weighing and assorting of all the evidence contributed by the investigators in all departments. Since anthropology will benefit so largely by the answer to this question her workers should contribute their share toward its solution.

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